DATA SHEET

# SKY67106-306LF: 1.5-3.0 GHz Two-Stage, High Linearity and High Gain Low-Noise Amplifier

## Applications

- CDMA, WCDMA, TD-SCDMA, WiMAX, and LTE cellular infrastructure systems
- Ultra low-noise, high gain and high linearity systems

## Features

- Ultra-low NF: 0.65 dB @ 1950 MHz
- High gain: 35 dB @ 1950 MHz
- Low quiescent current: 100 mA
- Stage 1 adjustable gain and current
- Wideband performance, useable to 3 GHz
- Small, QFN (16-pin, 4 x 4 mm) Pb-free package (MSL1, 260 °C per JEDEC J-STD-020)

**Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to *Skyworks Definition of Green™*, document number SQ04-0074.**

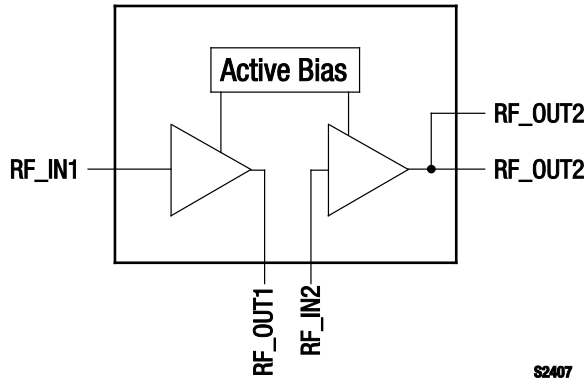



**Figure 1. SKY67106-306LF Block Diagram**

## Description

The SKY67106-306LF is a GaAs pHEMT and HBT two-stage, Low-Noise Amplifier (LNA) with active bias and high linearity performance. The pHEMT front end of the device provides an ultra-low Noise Figure (NF) while the HBT output stage provides high gain, linearity, and efficiency.

The SKY67106-306LF operates in the frequency range of 1.5 to 3.0 GHz. For lower frequency operation, the pin and layout-compatible SKY67105-306LF (Data Sheet document # 201518) should be used.

The SKY67106-306LF is provided in a 4 x 4 mm, 16-pin Quad Flat No-Lead (QFN) package. A functional block diagram is shown in Figure 1. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

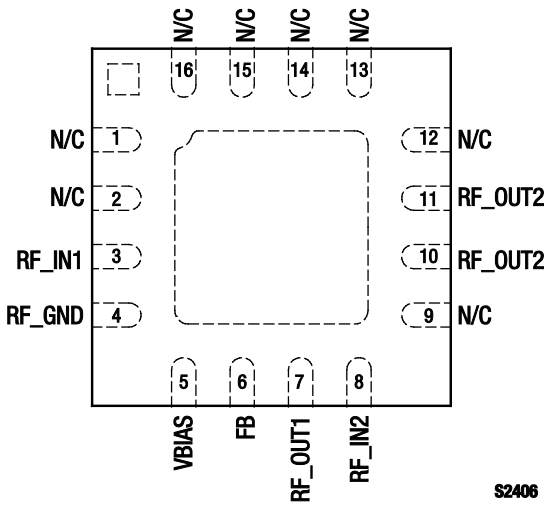



**Figure 2. SKY67106-306LF Pinout – 16-Pin QFN (Top View)**

**Table 1. SKY67106-306LF Signal Descriptions**

| Pin # | Name | Description | Pin # | Name | Description |
|---|---|---|---|---|---|
| 1 | N/C | No connection. May be grounded with no change in performance. | 9 | N/C | No connection. May be grounded with no change in performance. |
| 2 | N/C | No connection. May be grounded with no change in performance. | 10 | RF_OUT2 | RF output of second stage amplifier |
| 3 | RF_IN1 | RF input to first stage amplifier | 11 | RF_OUT2 | RF output of second stage amplifier |
| 4 | RF_GND | RF ground for first stage amplifier | 12 | N/C | No connection. May be grounded with no change in performance. |
| 5 | VBIAS | Bias for first stage amplifier. External resistor sets current consumption. | 13 | N/C | No connection. May be grounded with no change in performance. |
| 6 | FB | Feedback pin for first stage amplifer. | 14 | N/C | No connection. May be grounded with no change in performance. |
| 7 | RF_OUT1 | RF output of first stage amplifer | 15 | N/C | No connection. May be grounded with no change in performance. |
| 8 | RF_IN2 | RF input to second stage amplifier | 16 | N/C | No connection. May be grounded with no change in performance. |

## Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY67106-306LF are provided in Table 2. Electrical specifications are provided in Table 3 (1950 MHz) and Table 4 (2600 MHz).

Typical performance characteristics of the SKY67106-306LF are illustrated in Figures 3 through 15 (1950 MHz) and in Figures 16 through 28 (2600 MHz).

**Table 2. SKY67106-306LF Absolute Maximum Ratings**

| Parameter | Symbol | Minimum | Maximum | Units |
|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | | 5.5 | V |
| RF input power | $P_{IN}$ | | +15 | dBm |
| Operating temperature | $T_{OP}$ | –40 | +85 | °C |
| Storage temperature | $T_{STG}$ | –40 | +125 | °C |
| Junction temperature | $T_J$ | | +150 | °C |
| Thermal resistance | $\Theta_{JC}$ | | 85 | °C/W |

**Note:** Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

***CAUTION**: Although this device is designed to be as robust as possible, Electrostatic Discharge (ESD) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times. The SKY67106-306LF is a Class 1B ESD device.*

**Table 3. SKY67106-306LF Electrical Specifications (Note 1)**
**($V_{DD}$ = +5 V, $T_{OP}$ = +25 °C, $P_{IN}$ = –30 dBm, Characteristic Impedance [$Z_0$] = 50 Ω, Optimized for 1950 MHz Operation, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| ***RF Specifications*** | | | | | | |
| Noise Figure | NF | @ 1950 MHz | | 0.65 | 0.87 | dB |
| Small signal gain | \|S21\| | @ 1950 MHz | 32.5 | 35.0 | | dB |
| Input return loss | \|S11\| | @ 1950 MHz | 10 | 14 | | dB |
| Output return loss | \|S22\| | @ 1950 MHz | 15 | 22 | | dB |
| Reverse isolation | \|S12\| | @ 1950 MHz | 50 | 55 | | dB |
| 3rd Order Input Intercept Point | IIP3 | @ 1950 MHz, Δf = 1 MHz, $P_{IN}$ = –30 dBm/tone | 0 | +2.5 | | dBm |
| 3rd Order Output Intercept Point | OIP3 | @ 1950 MHz, Δf = 1 MHz, $P_{IN}$ = –30 dBm/tone | +34.5 | +37.0 | | dBm |
| 1 dB Input Compression Point | IP1dB | @ 1950 MHz | –11 | –9 | | dBm |
| 1 dB Output Compression Point | OP1dB | @ 1950 MHz | +22 | +24 | | dBm |
| ***DC Specifications*** | | | | | | |
| Supply voltage | $V_{DD}$ | | 3.5 | 5.0 | 5.5 | V |
| Quiescent current | $I_{DD}$ | Set with external resistor | | 100 | 125 | mA |
| Supply current @ IP1dB | $I_{DD\_P1DB}$ | Set with external resistor | | 160 | 190 | mA |

**Note 1:** Performance is guaranteed only under the conditions listed in this Table.

## Typical Performance Characteristics (1950 MHz)

**($V_{DD}$ = +5 V, $T_{OP}$ = +25 °C, $P_{IN}$ = –30 dBm, Characteristic Impedance [$Z_0$] = 50 Ω, Optimized for 1950 MHz Operation, Unless Otherwise Noted)**

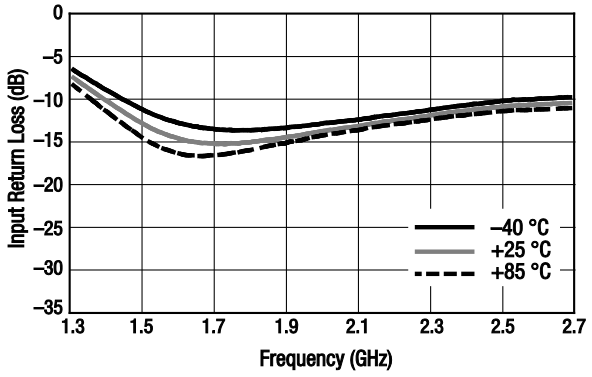



**Figure 3. Input Return Loss vs Frequency Over Temperature, Narrow Band**

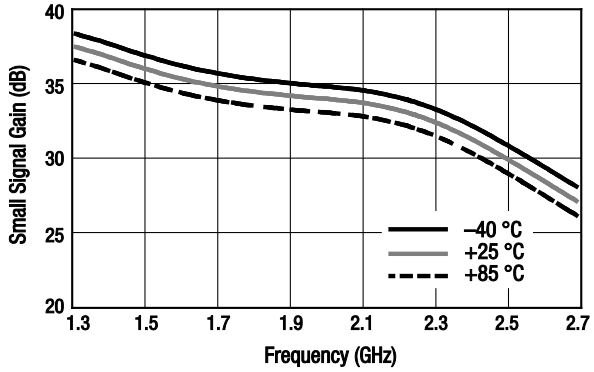



**Figure 4. Small Signal Gain vs Frequency Over Temperature, Narrow Band**

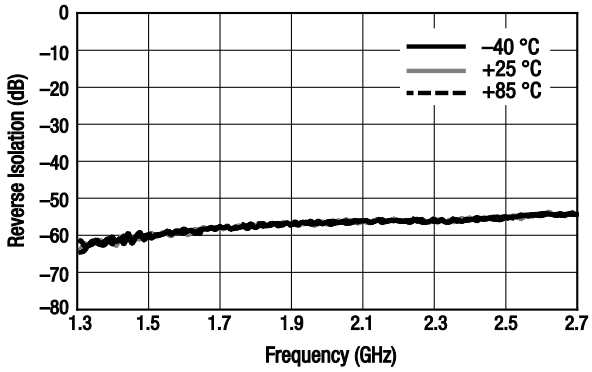



**Figure 5. Reverse Isolation vs Frequency Over Temperature, Narrow Band**

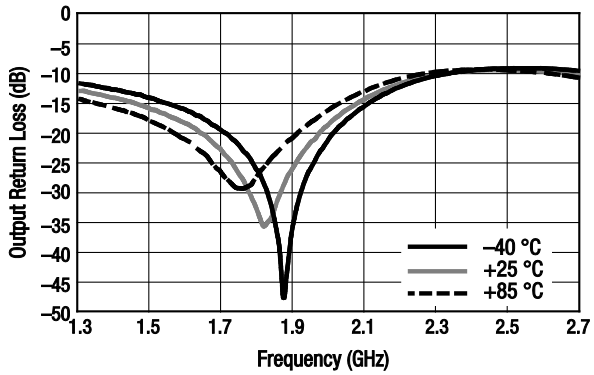



**Figure 6. Output Return Loss vs Frequency Over Temperature, Narrow Band**

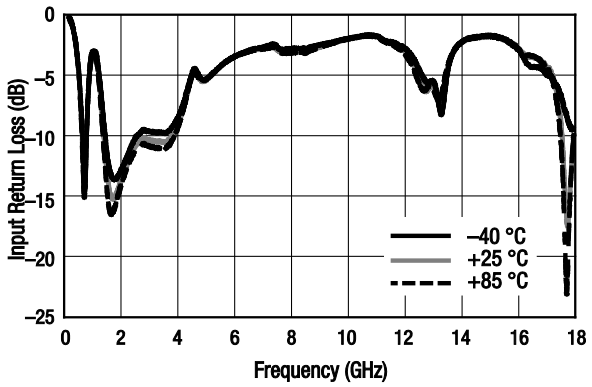



**Figure 7. Input Return Loss vs Frequency Over Temperature, Wide Band**

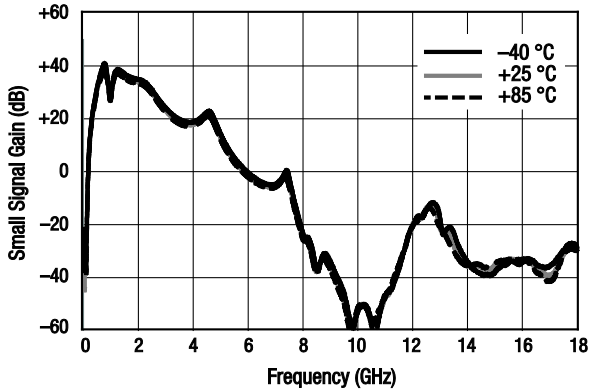



**Figure 8. Small Signal Gain vs Frequency Over Temperature, Wide Band**

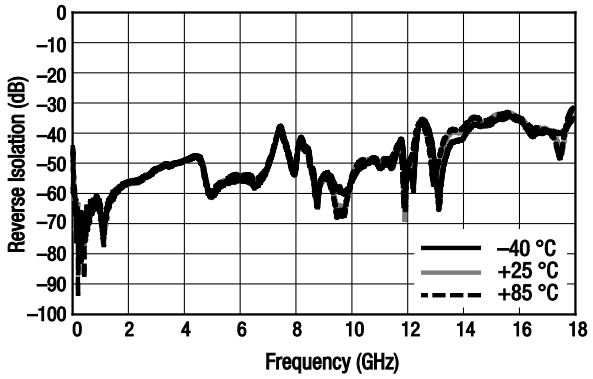



**Figure 9. Reverse Isolation vs Frequency Over Temperature, Wide Band**

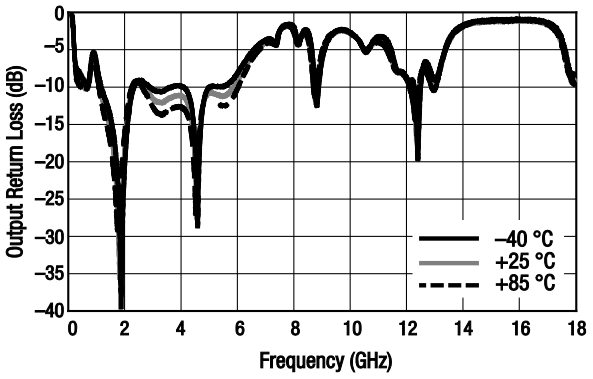



**Figure 10. Output Return Loss vs Frequency Over Temperature, Wide Band**

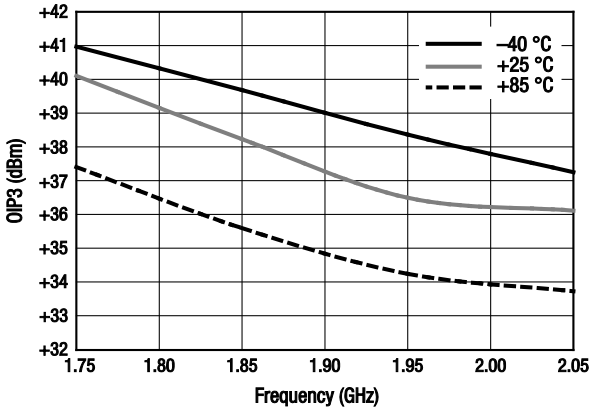



**Figure 11. OIP3 vs Frequency Over Temperature**

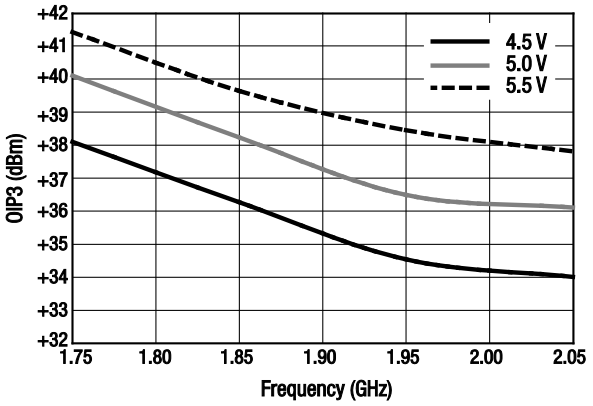



**Figure 12. OIP3 vs Frequency Over Voltage**

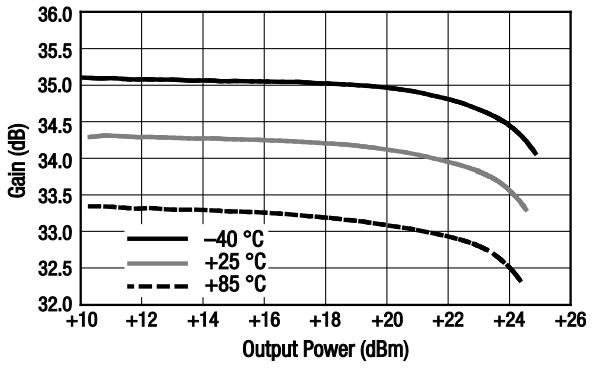



**Figure 13. Gain vs Output Power Over Temperature**

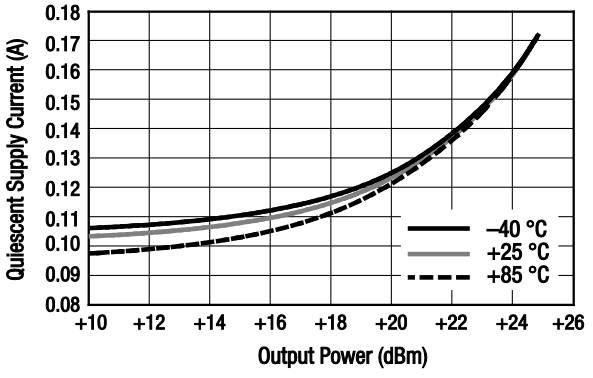



**Figure 14. Quiescent Supply Current vs Output Power Over Temperature**

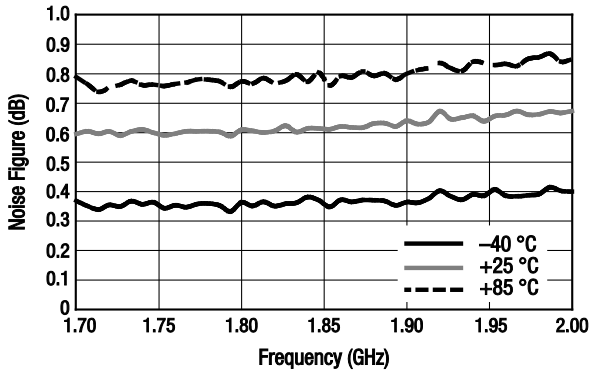



**Figure 15. Noise Figure vs Frequency Over Temperature**

**Table 4. SKY67106-306LF Electrical Specifications (Note 1)**
**($V_{DD}$ = +5 V, $T_{OP}$ = +25 °C, $P_{IN}$ = –30 dBm, Characteristic Impedance [$Z_0$] = 50 Ω, Optimized for 2600 MHz Operation, Unless Otherwise Noted)**

| Parameter | Symbol | Test Condition | Min | Typical | Max | Units |
|---|---|---|---|---|---|---|
| ***RF Specifications*** | | | | | | |
| Noise Figure | NF | @ 2600 MHz | | 0.92 | 1.10 | dB |
| Small signal gain | \|S21\| | @ 2600 MHz | 28 | 31 | | dB |
| Input return loss | \|S11\| | @ 2600 MHz | 8 | 10 | | dB |
| Output return loss | \|S22\| | @ 2600 MHz | 18 | 30 | | dB |
| Reverse isolation | \|S12\| | @ 2600 MHz | 48 | 53 | | dB |
| 3rd Order Input Intercept Point | IIP3 | @ 2600 MHz, Δf = 1 MHz, $P_{IN}$ = –30 dBm/tone | +1 | +4 | | dBm |
| 3rd Order Output Intercept Point | OIP3 | @ 2600 MHz, Δf = 1 MHz, $P_{IN}$ = –30 dBm/tone | +32 | +35 | | dBm |
| 1 dB Input Compression Point | IP1dB | @ 2600 MHz | –9.5 | –7 | | dBm |
| 1 dB Output Compression Point | OP1dB | @ 2600 MHz | +21.5 | +24 | | dBm |
| ***DC Specifications*** | | | | | | |
| Supply voltage | $V_{DD}$ | | 3.5 | 5.0 | 5.5 | V |
| Quiescent current | $I_{DD}$ | Set with external resistor | | 98 | 125 | mA |
| Supply current @ IP1dB | $I_{DD\_P1DB}$ | Set with external resistor | | 160 | 190 | mA |

**Note 1:** Performance is guaranteed only under the conditions listed in this Table.

## Typical Performance Characteristics (2600 MHz)

**($V_{DD}$ = +5 V, $T_{OP}$ = +25 °C, $P_{IN}$ = –30 dBm, Characteristic Impedance [$Z_0$] = 50 Ω, Optimized for 2600 MHz Operation, Unless Otherwise Noted)**

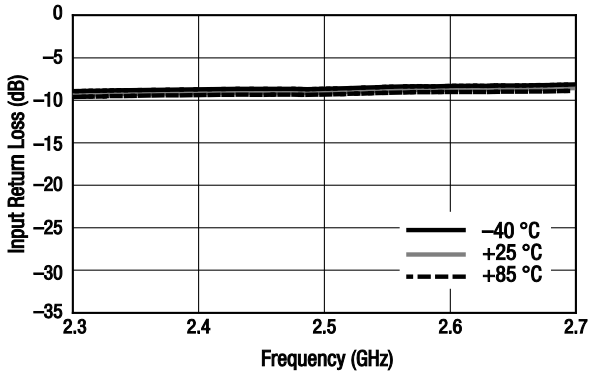



**Figure 16. Input Return Loss vs Frequency Over Temperature, Narrow Band**

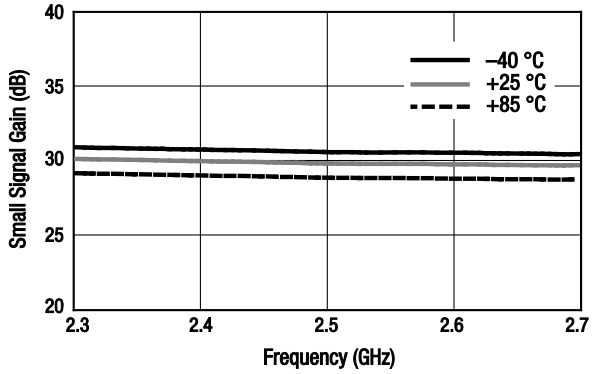



**Figure 17. Small Signal Gain vs Frequency Over Temperature, Narrow Band**

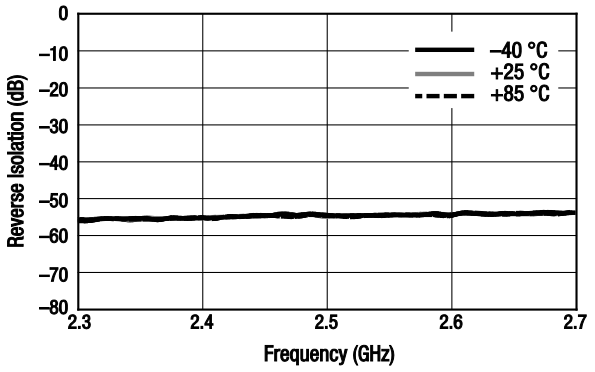



**Figure 18. Reverse Isolation vs Frequency Over Temperature, Narrow Band**

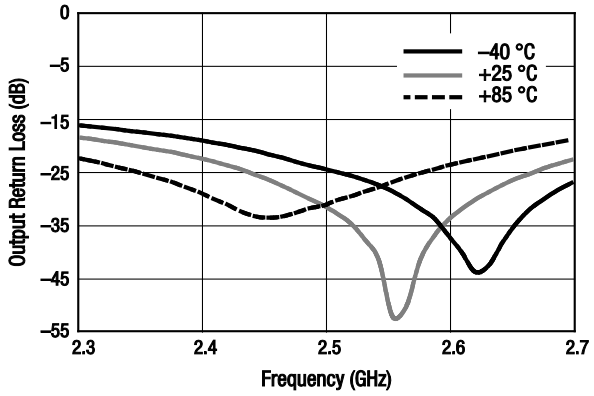



**Figure 19. Output Return Loss vs Frequency Over Temperature, Narrow Band**

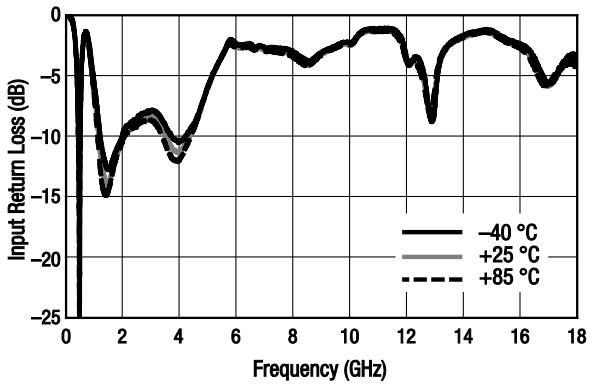



**Figure 20. Input Return Loss vs Frequency Over Temperature, Wide Band**

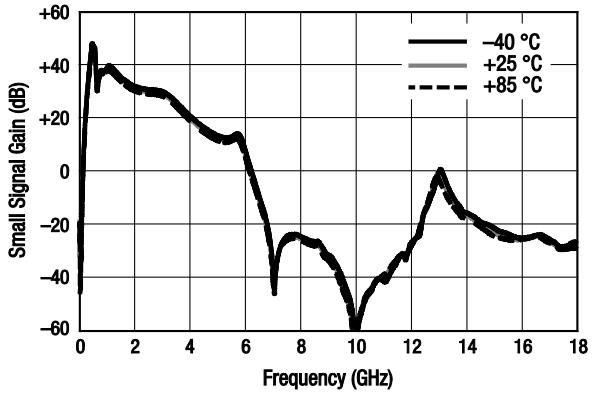



**Figure 21. Small Signal Gain vs Frequency Over Temperature, Wide Band**

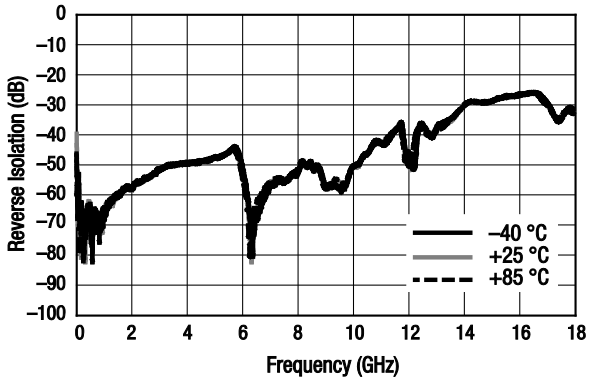



**Figure 22. Reverse Isolation vs Frequency Over Temperature, Wide Band**

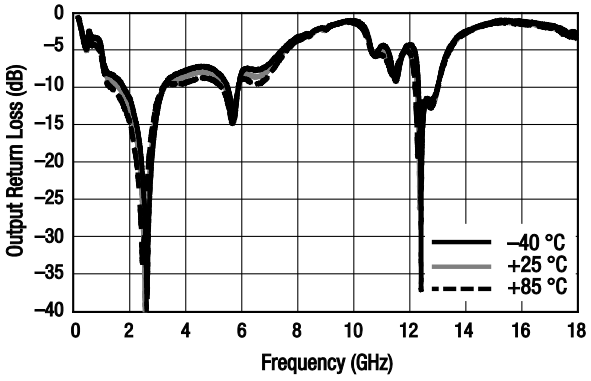



**Figure 23. Output Return Loss vs Frequency Over Temperature, Wide Band**

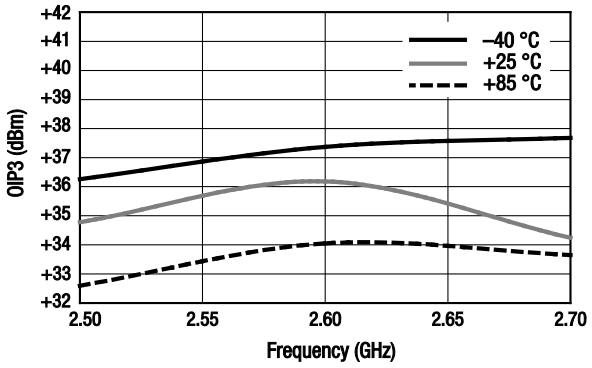



**Figure 24. OIP3 vs Frequency Over Temperature**

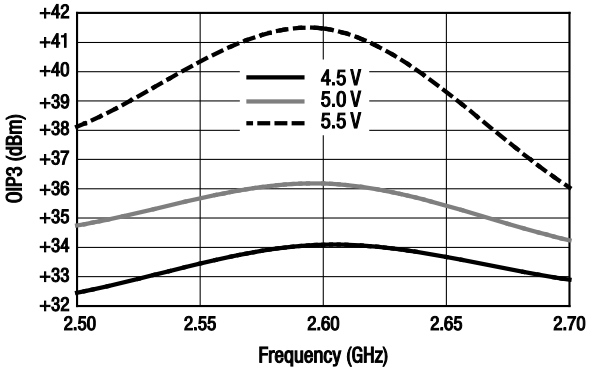



**Figure 25. OIP3 vs Frequency Over Voltage**

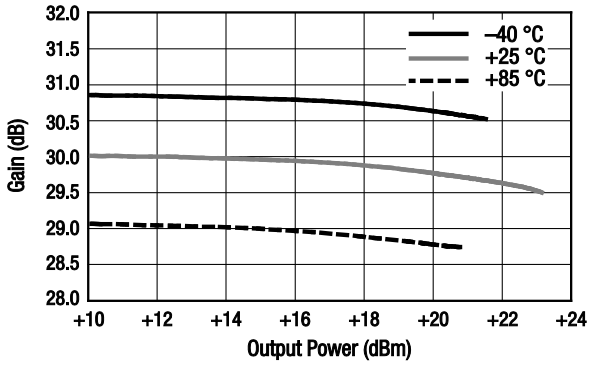



**Figure 26. Gain vs Output Power Over Temperature**

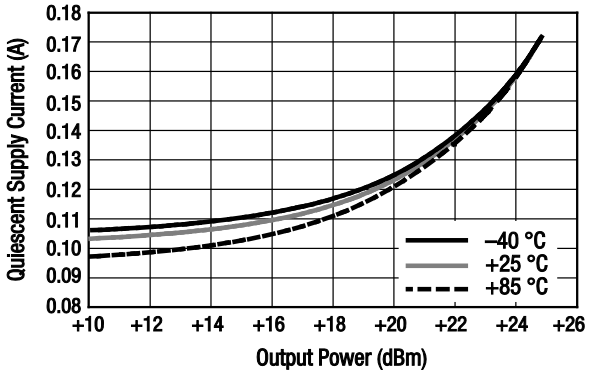



**Figure 27. Quiescent Supply Current vs Output Power Over Temperature**

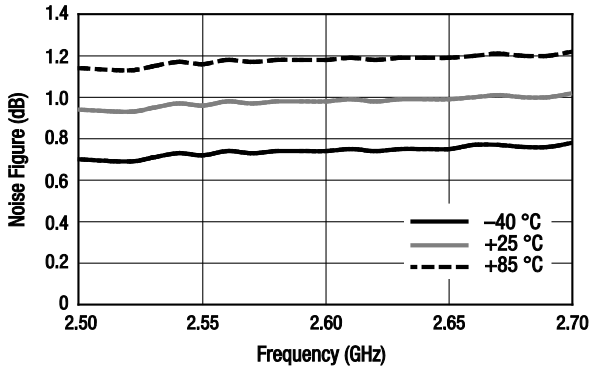



**Figure 28. Noise Figure vs Frequency Over Temperature**

## Evaluation Board Description

The SKY67106-306LF Evaluation Board is used to test the performance of the SKY67106-306LF two-stage LNA. An Evaluation Board schematic diagram is provided in Figure 29 (1950 MHz) and Table 5 provides the Evaluation Board Bill of Materials (1950 MHz).

An Evaluation Board schematic diagram is provided in Figure 30 (2600 MHz) and Table 6 provides the Evaluation Board Bill of Materials (2600 MHz).

Evaluation Board assembly drawings are shown in Figure 31 (1950 MHz) and in Figure 32 (2600 MHz).

This Evaluation Board has many unused pads for components so that it can accommodate tuning over a wide range of frequencies. Refer to the relevant assembly diagram, schematic, and Bill of Materials for the correct component values and placements for a particular operating frequency.

Note that the VDD3 pin on the Evaluation Board does not need to be connected and should be left open.

## Package Dimensions

The PCB layout footprint for the SKY67106-306LF is shown in Figure 33. Typical case markings are noted in Figure 34. Package dimensions for the 16-pin QFN are shown in Figure 35, and tape and reel dimensions are provided in Figure 36.

## Package and Handling Information

Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

THE SKY67106-306LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *Solder Reflow Information*, document number 200164.

Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.

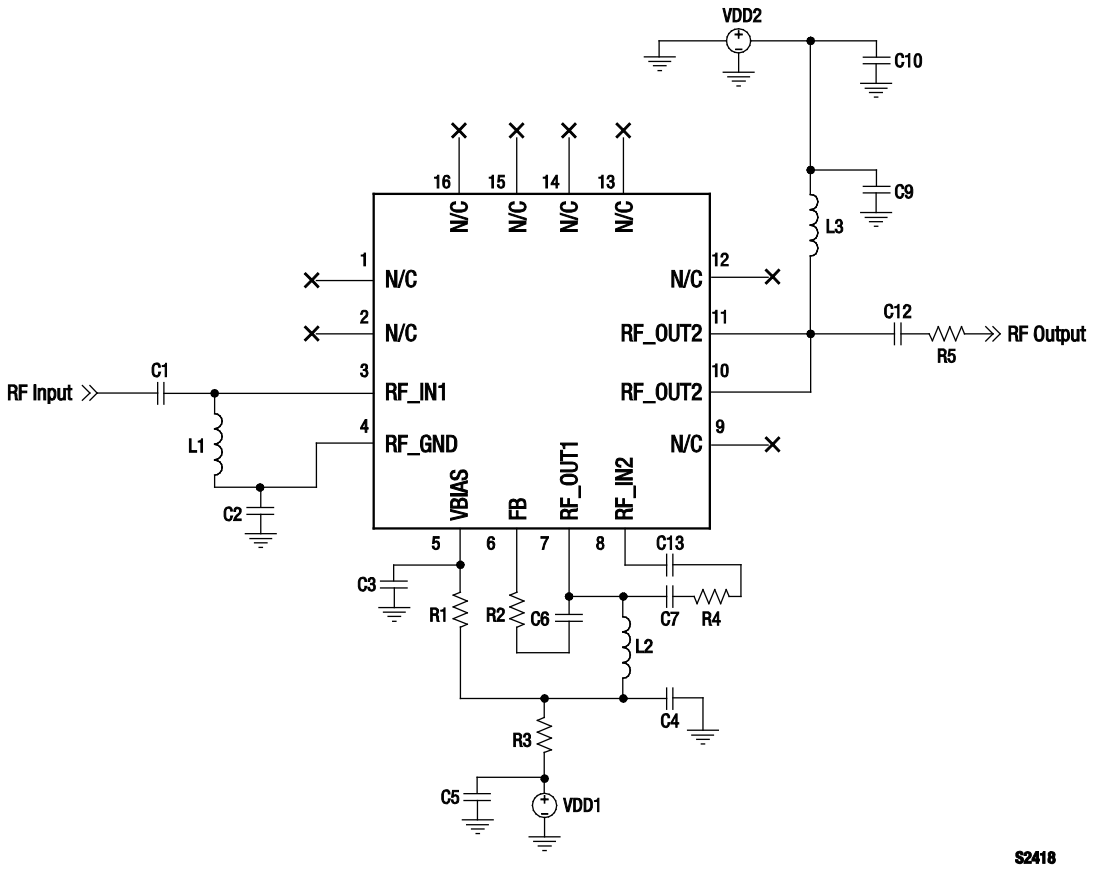



**Figure 29. SKY67106-306LF Evaluation Board Schematic (1950 MHz)**

**Table 5. SKY67106-306LF Evaluation Board Bill of Materials (1950 MHz)**

| Component | Value | Size | Manufacturer | Manufacturer Part Number |
|---|---|---|---|---|
| C1 | 18 pF | 0402 | Murata GJM | |
| C2 | 9 pF | 0402 | Murata GJM | |
| C3 | 0.1 µF | 0402 | Murata GRM | |
| C6, C9 | 2.7 pF | 0402 | Murata GRM | |
| C7 | 3.9 pF | 0402 | Murata GRM | |
| C4 | 10000 pF | 0402 | Murata GRM | |
| C5 | 1000 pF | 0402 | Murata GRM | |
| C10 | 100 pF | 0402 | Murata GRM | |
| C12 | 12 pF | 0402 | Murata GRM | |
| C13 | 22 pF | 0402 | Murata GRM | |
| L1 | 4.3 nH | 0402 | Coilcraft HP | |
| L2 | 3.3 nH | 0402 | TDK MLG | |
| L3 | 27 nH | 0402 | TDK MLG | |
| R1 | 2 kΩ | 0402 | Panasonic 1% | |
| R2 | 200 Ω | 0402 | Panasonic 1% | |
| R3, R4, R5 | 0 Ω | 0402 | Panasonic | |

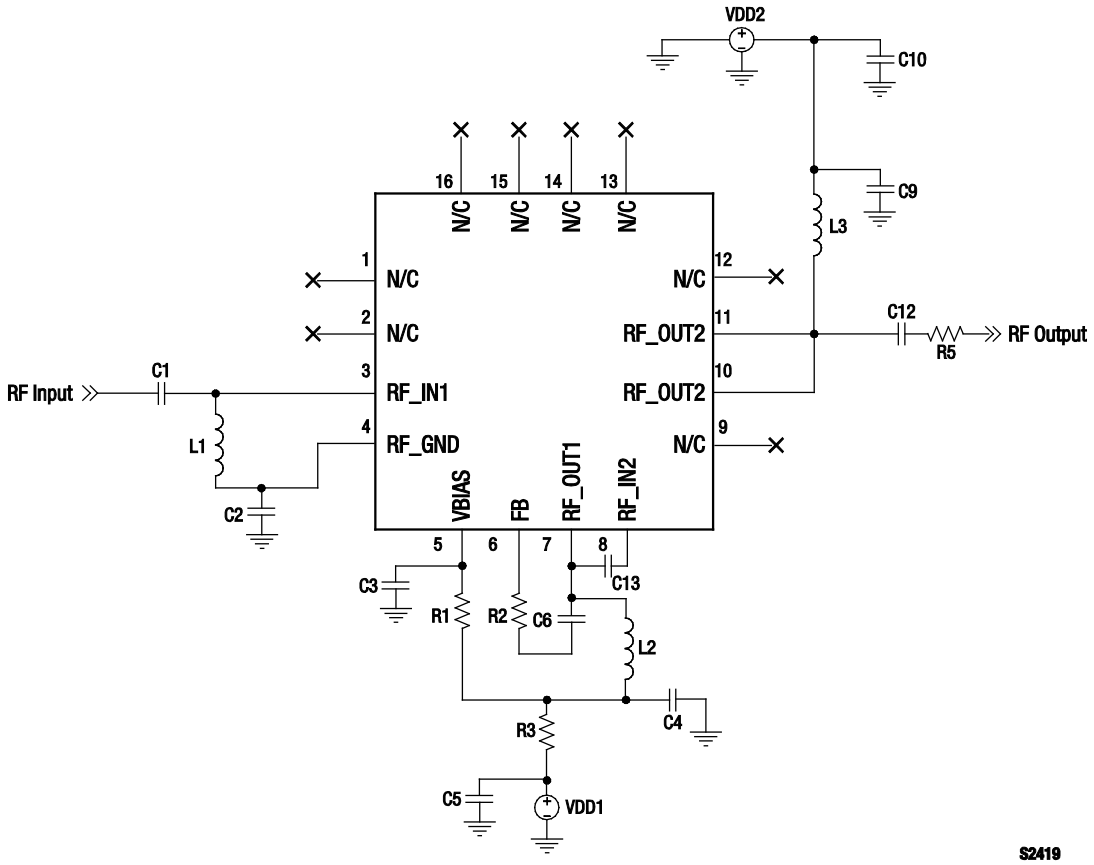
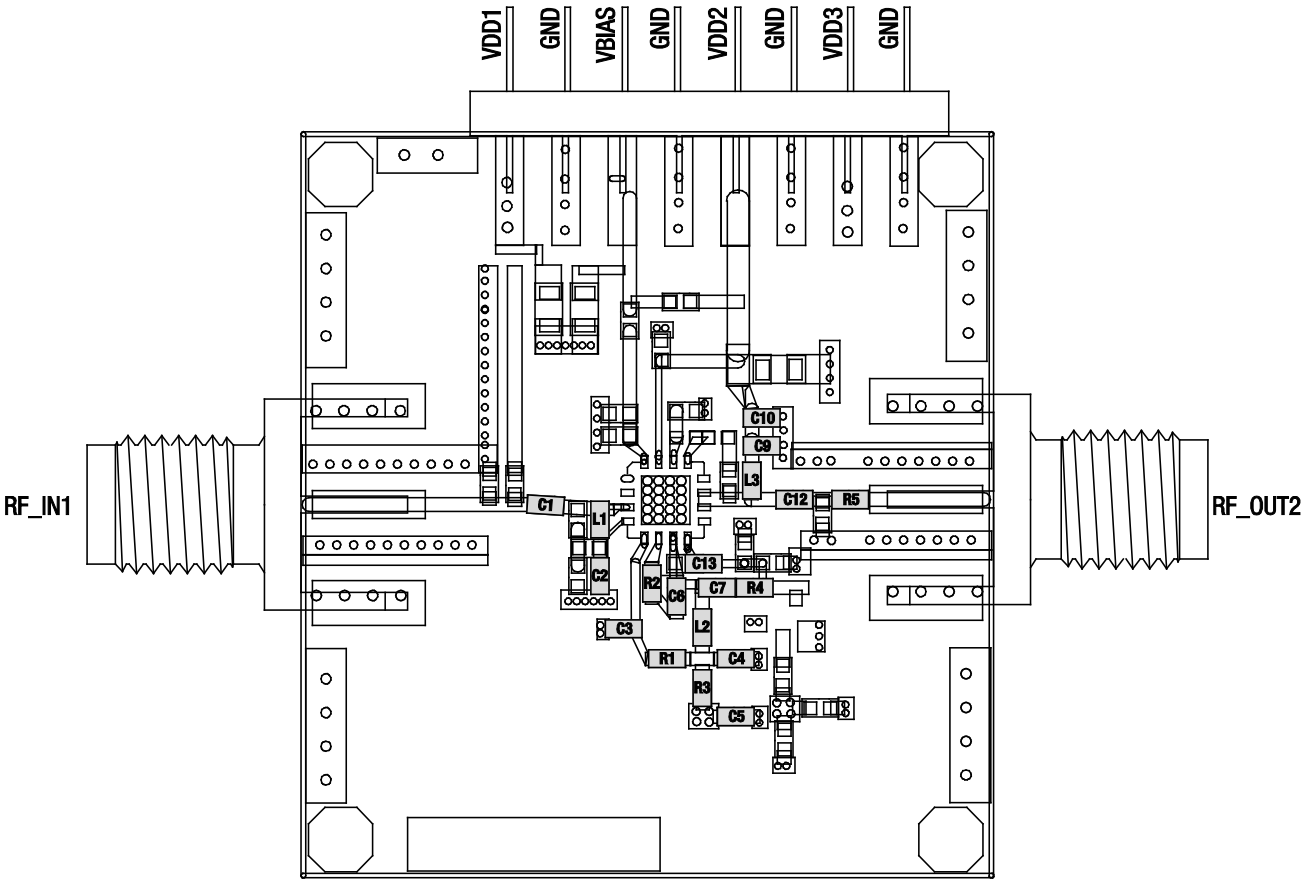



**Figure 30. SKY67106-306LF Evaluation Board Schematic (2600 MHz)**

**Table 6. SKY67106-306LF Evaluation Board Bill of Materials (2600 MHz)**

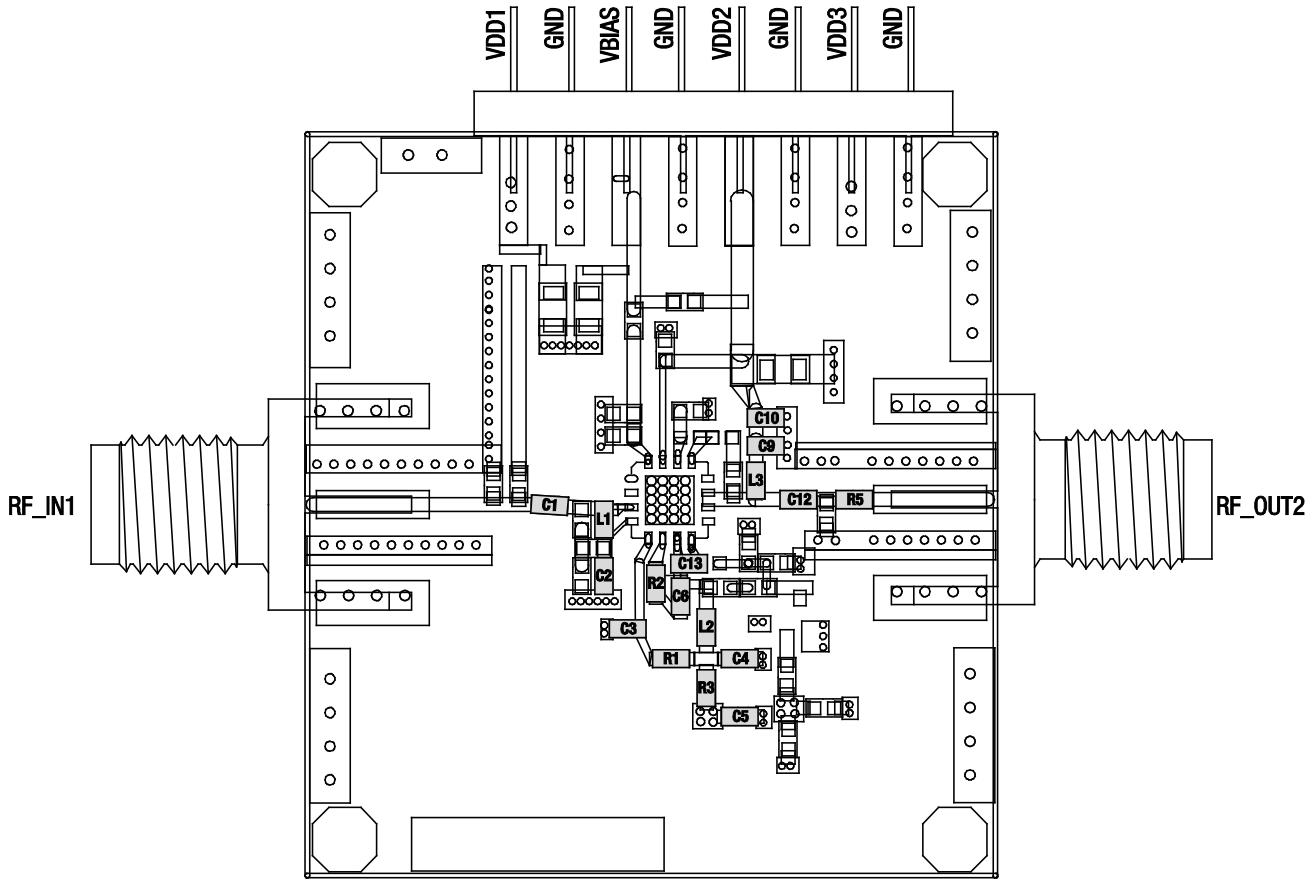
| Component | Value | Size | Manufacturer | Manufacturer Part Number |
|---|---|---|---|---|
| C1 | 10 pF | 0402 | Murata GJM | |
| C2 | 20 pF | 0402 | Murata GJM | |
| C3 | 0.1 μF | 0402 | Murata GRM | |
| C6, C9 | 2.7 pF | 0402 | Murata GRM | |
| C4 | 10000 pF | 0402 | Murata GRM | |
| C5, C10 | 1000 pF | 0402 | Murata GRM | |
| C12 | 39 pF | 0402 | Murata GRM | |
| C13 | 15 pF | 0402 | Murata GRM | |
| L1 | 5.1 nH | 0402 | Coilcraft CS | |
| L2 | 3.3 nH | 0402 | TDK MLG | |
| L3 | 10 nH | 0402 | TDK MLG | |
| R1 | 2 kΩ | 0402 | Panasonic 1% | |
| R2 | 200 Ω | 0402 | Panasonic 1% | |
| R3, R5 | 0 Ω | 0402 | Panasonic | |




*Note: The VDD3 pin should be left unconnected.*

S2503

**Figure 31. SKY67106-306LF Evaluation Board Assembly Diagram (1950 MHz)**




*Note: The VDD3 pin should be left unconnected.* **S2504**

**Figure 32. SKY67106-306LF Evaluation Board Assembly Diagram (2600 MHz)**

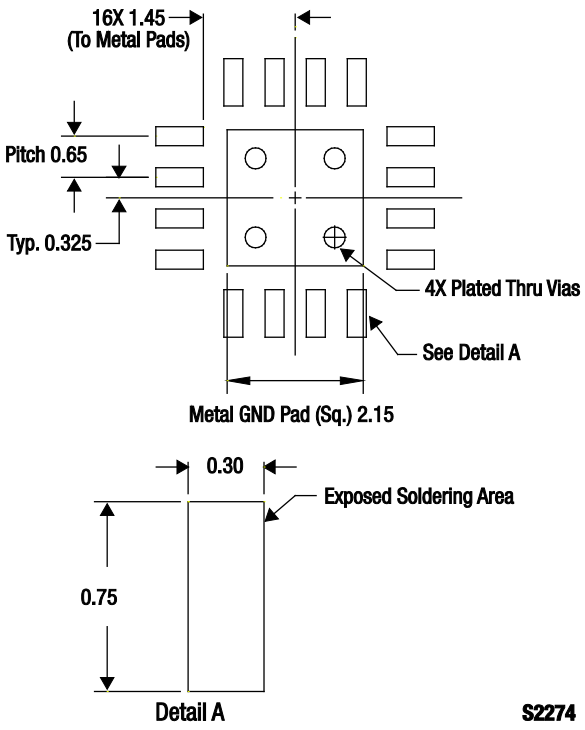



**Figure 33. SKY67106-306LF PCB Layout Footprint**

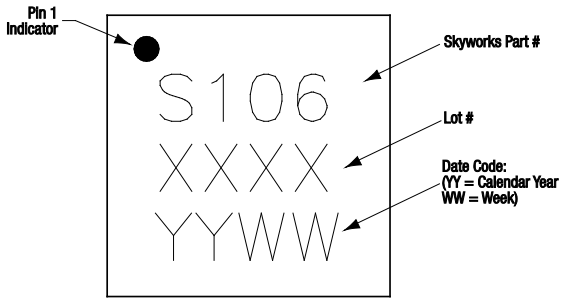
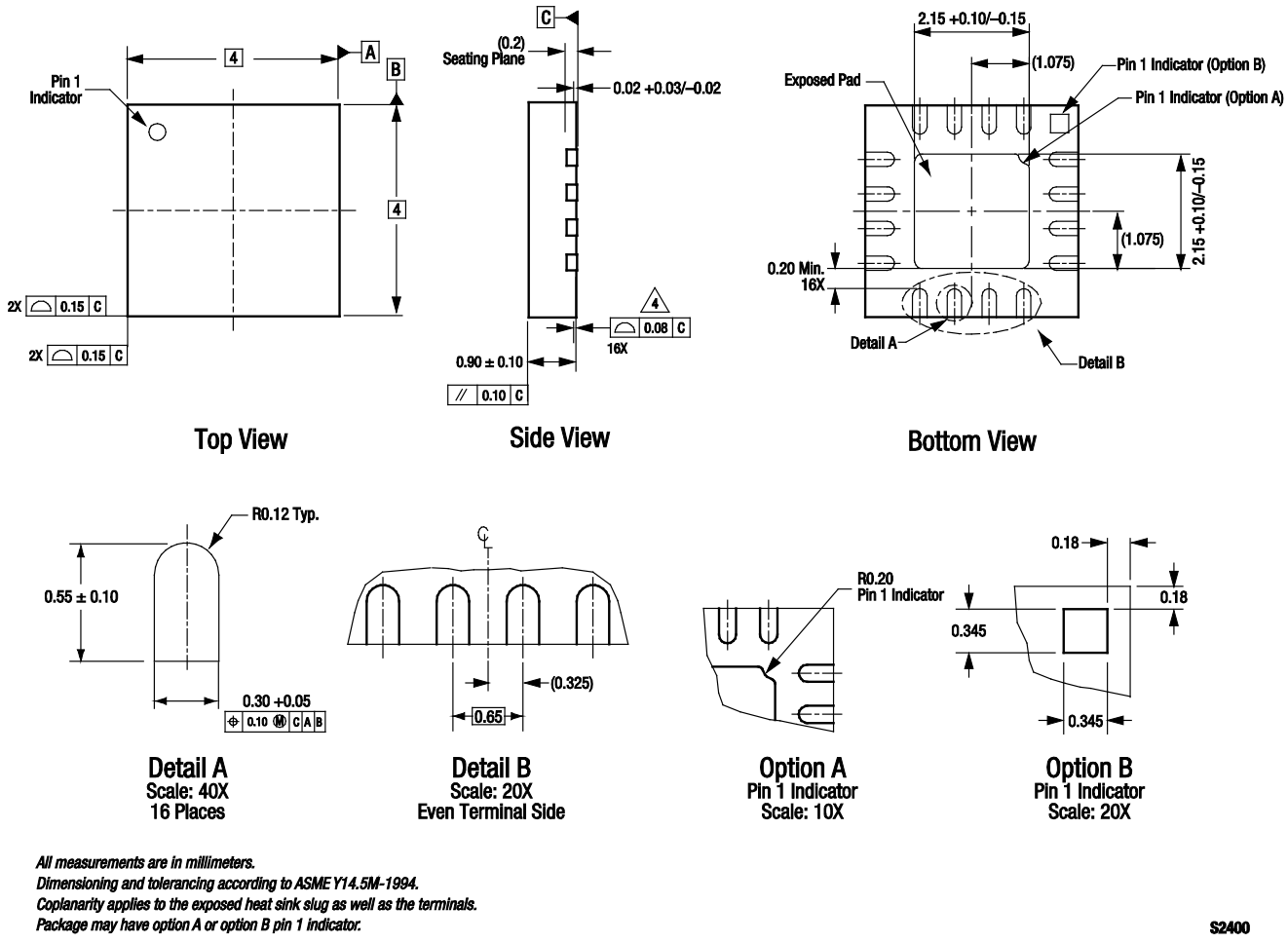


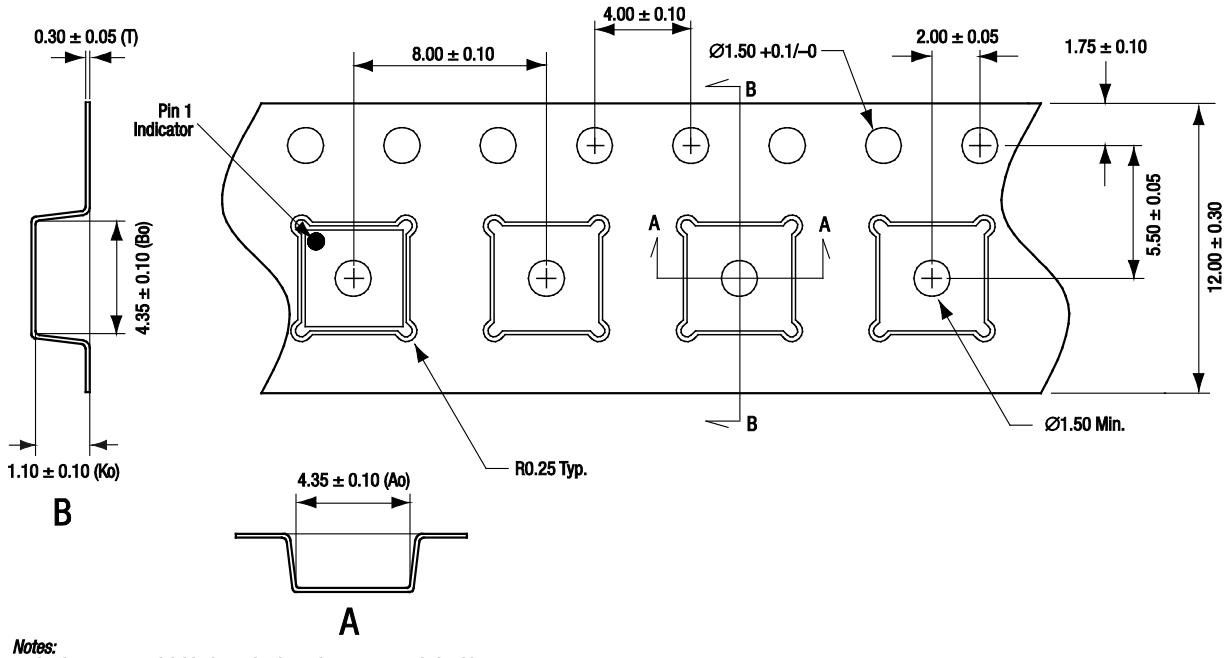

**Figure 34. Typical Case Markings**




*All measurements are in millimeters.*
*Dimensioning and tolerancing according to ASME Y14.5M-1994.*
*Coplanarity applies to the exposed heat sink slug as well as the terminals.*
*Package may have option A or option B pin 1 indicator.*

S2400

**Figure 35. SKY67106-306LF 16-Pin QFN Package Dimensions**




*Notes:*
*1. Carrier tape material: black conductive polystyrene, non-bakeable*
*2. Cover tape material: transparent conductive HSA*
*3. Cover tape size: 9.2 mm width*
*4. ESD surface resistivity is ≥1 x $10^5$ ~ ≤ 1 x $10^{10}$ Ohms/square per EIA, JEDEC TNR Specification.*
*5. All measurements are in millimeters*

S1846

**Figure 36. SKY67106-306LF Tape and Reel Dimensions**

## Ordering Information

| Model Name | Manufacturing Part Number | Evaluation Board Part Number |
|---|---|---|
| SKY67106-306LF Two-Stage LNA | SKY67106-306LF | SKY67106-306LF-EVB |

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